Amendments to the Drawings:

Please add the attached sheet (Fig. 11) as a new formal drawing figure to appear after the originally submitted sheets (Figs. 1-10). No changes are made to the originally submitted sheets (Figs. 1-10).

Attachment: New Drawing Sheet

REMARKS

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

I. Introduction

In the specification, new paragraphs have been added on page 19 of the specification. In the drawings, new Figure 11 has been added. Support for the new paragraphs and for new Figure 11 may be found on page 11, last paragraph (which incorporates by reference U.S. application 10/613,071 which discloses an LED on page 63, line 8 to page 65, line 7 with regard to Figure 15). These new paragraphs and new Figure 11 were copied verbatim from U.S. application 10/613,071, except that Figure 15 was relabeled Figure 11 for consistency with the instant application. No new matter was added.

Claims 36, 37, 39-41 and 44-48 are pending in this application. Claim 48 has been added. Claim 48 was previously numbered claim 42. Support for new claim 48 may be found throughout the specification, such as on page 15, line 14 to page 18, line 15 of the specification and in Figures 4-7. No new matter was added.

II. The § 112, ¶1 Rejection Should Be Withdrawn

Claims 36-37, 39, 40 and 46 are rejected under § 112, ¶1 as lacking an adequate written description. The Office Action states that applicants have not taught or suggested forming a light emitting diode with the structure claimed. Applicants respectfully disagree.

Light emitting diode (LED) nanowhiskers formed by Chemical Beam Epitaxy (CBE) are taught throughout U.S. application 10/613,071, the entirety of which had been incorporated by reference on page 11, last paragraph of the instant application as originally filed. The statement of incorporation on page 11 of the instant application is reproduced below:

> The embodiments to be described are all formed with nanowhiskers, preferably according to the Chemical Beam Epitaxy method (CBE) described in copending U.S. Patent

> Application No. 10/613,971 filed July 7, 2003, the contents of which are herein incorporated by reference.

U.S. Application No. 10/814,630, page 11, last paragraph (emphasis added).

Specifically, the incorporated U.S. application 10/613,071 teaches that CBE can be used to form nanowhiskers (e.g., page 41, line 23 to page 42, line 3) which can be used in an LED, as described in the incorporated U.S. application 10/613,071 on page 63, line 8 to page 65, line 7 with regard to Figure 15. Thus, the claimed device is adequately supported by the instant application by way of U.S. application 10/613,071, the contents of which were incorporated herein.

The incorporated U.S. application 10/613,071 should be treated as if it had been literally reproduced in the instant application. The MPEP states, "The information incorporated is as much a part of the application as filed as if the text was repeated in the application, and should be treated as part of the text of the application as filed." MPEP § 608.01(p) (emphasis added). Thus, the contents of U.S. application 10/613,071, which describes LED nanowhiskers formed by Chemical Beam Epitaxy, should be treated as the text of the instant application as filed. Therefore, the rejection should thus be withdrawn.

Without acquiescing to the appropriateness of the rejection and for the elimination of doubt that the claimed LED structure in claims 36-37, 39, 40 and 46 contains literal support in the specification, Applicants have added new paragraphs on page 19 of the specification and new Figure 11, which are reproductions of page 63, line 8 to page 65, line 7 and Figure 15 of the incorporated U.S. application 10/613,071, respectively. These amendments do not constitute new matter because, as previously explained, the contents of the incorporated U.S. application 10/613,071 should be treated as having been originally included in the instant application as filed.

In view of the foregoing, Applicants respectfully request that the rejection be withdrawn.

III. The § 103(a) Rejection Should Be Withdrawn

Claims 41, 42,[1] 45 and 47 are rejected under § 103(a) as being obvious over Yazawa (U.S. Patent No. 5,362,972). The Office Action asserts that it would have been obvious to dope the nanowhisker of Yazawa p-type in order to achieve the claimed invention. This rejection is respectfully traversed.

A. Yazawa does not teach oppositely-doped nanowhisker and enclosure

Claim 41 recites a nanowhisker having "a first conductivity type" and an enclosure having "a second conductivity type opposite to the first conductivity type." (emphasis added) Because Yazawa fails to teach this combination of oppositely doped nanowhisker and enclosure, Yazawa does not teach or suggest all elements of the claim.

In contrast with claim 41, Yazawa only teaches two possible combinations of conductivity type: (a) an undoped nanowhisker with a n-type enclosure, or (b) an n-type nanowhisker with an insulating enclosure. Indeed, the Office Action on page 3 states, "Yazawa does not teach doping the whisker p-type (a first conductivity)."

Referring to Figure 1, Yazawa clearly states that either the nanowhisker must be undoped or the enclosure must be insulating:

> The FET in FIG. 1 shows a case in which carriers are electrons. Electrons reach a drain electrode 3 from a source electrode 5 through a conductive semiconductor substrate (source) 11 and whisker channels 1. A material of a layer shown at 6 is selected in relationship with carrier generation in the channels. In case the whiskers themselves have conductivity, an insulating material is selected, and when the whiskers have no conductivity (undoped), a HEMT mechanism for instance, i.e., an n-type semiconductor having smaller electron affinity than that of the whiskers is selected. In this case, a band diagram at a junction portion between the whisker channels 1 and the n-type semiconductor layer 6 is as shown in FIG. 2, and a one dimensional electron gas (1 DEG) is confined in the whisker channels 1. [emphasis added]

Col. 6, lines 23-34.

[1] New claim 48 was previously labeled claim 42.

And again, referring to Figure 8, Yazawa continues to limit the FET device to having either (a) an undoped GaAs whisker 1 with n-AlGaAs layer 6A, or (b) n-type GaAs whisker 1 with SOG/polyimide insulator 6A:

> Next, undoped GaAs whisker channels 1 are grown selectively on the substrate by organometallic vapor phase growth (MOCVD method). It is possible to control density, length, outside diameter and the like of the whisker channel by growth conditions. Further, since these whisker channels have a property to grow in a direction <111>B, they grow vertically with respect to the substrate surface as shown in FIG. 11. Besides, in the present embodiment, the substrate temperature is set at 480°C., the raw material gas ratio of V group to III group (AsH_3 and TMG, respectively) is set at V/III=20, and the growth time is set to 200 sec. At this time, the density of the whisker 1 which has grown at the opening portion is 10^6 lines/mm^2 and the length thereof is at approximately 1 μm. This whisker channel 1 has a configuration in which the outside diameter thereof is reduced gradually as approaching a tip from a root portion of the crystal, but the intermediate portion thereof which joins with a gate 2 has an almost uniform outside diameter of 400 Å. Then, in order to confine electrons in the whisker channel 1, an n-AlGaAs layer 6A having a carrier density of 5×10^{17} /cm^3 in the thickness of 0.5 μm is made to grow in a manner of burying the whiskers by MBE or MOCVD. At this time, since the n-AlGaAs-GaAs junction has a well known selective dope structure and has a band diagram such as shown in FIG. 2, electrons are confined in the whisker channels 1. Naturally, a GaAs crystal doped in an n-type may be grown as the whisker channel 1 and SOG (Spin on Glass) or polyimide and the like may be used as an insulator 6A, but the above-mentioned method is preferable in order to separate static-ionized impurities from electrons in the channel so as to increase electron mobility in the channel 1. [emphasis added]

Col. 15, lines 8-41.

Thus, Yazawa fails to teach the claimed combination of oppositely doped nanowhisker and enclosure. This omission by Yazawa is not accidental but intentional, since the combination of oppositely doped nanowhisker and enclosure would probably render the device of Yazawa inoperative for the reasons explained below.

B. Examiner's Proposed Modification Would Render Yazawa's Device Inoperative

The MPEP states, "If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." MPEP § 2143.01 (citing *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959)). Similarly, "[i]f proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." MPEP § 2143.01 (citing *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)). Here, because the examiner's proposed modification of Yazawa would render Yazawa's invention inoperative, claims 41-42, 45 and 47 are not obvious over Yazawa.

Yazawa discloses a field effect transistor (FET). It is well known that a FET requires a conductive channel between a source and a drain. The channel used in the FET of Yazawa is either (a) a one dimensional electron gas (1 DEG) confined in an undoped nanowhisker 1 surrounded by n-type enclosure 6 to form a HEMT-type transistor, or (b) a channel in an n-type nanowhisker 1 isolated from other nanowhiskers by an insulating enclosure 6. These two choices of carrier type are explained by Yazawa in column 6, lines 27-38, reproduced below:

> A material of a layer shown at 6 is selected in relationship with carrier generation in the channels. In case the whiskers themselves have conductivity, an insulating material is selected, and when the whiskers have no conductivity (undoped), a HEMT mechanism for instance, i.e., an n-type semiconductor having smaller electron affinity than that of the whiskers is selected. In this case, a band diagram at a junction portion between the whisker channels 1 and the n-type semiconductor layer 6 is as shown in FIG. 2, and a one dimensional electron gas (1 DEG) is confined in the whisker channels 1. [emphasis added]

With regard to choice (a), when the nanowhisker 1 is an undoped semiconductor nanowhisker, a one dimensional electron gas (1 DEG) is confined by the n-doped layer 6 in the nanowhisker channels 1, as shown by the band diagram in Figure 2 of Yazawa. Thus, a HEMT (high electron mobility transistor) mechanism is formed by the heterojunction 1, 6. In

a HEMT (which is a type of FET), the electrons from the doped high-bandgap enclosure move into a steep potential well near the undoped lower-bandgap nanowhisker 1. Hence, the electrons in the steep potential well can move quickly without colliding with any impurities because the nanowhisker 1 is undoped. In other words, electrons are produced from the n-type dopants of the enclosure and can conduct through the undoped channel 1 without the disadvantage of impurity scattering and the corresponding reduction in mobility. Thus, a HEMT mechanism relies on an undoped, very thin channel to obtain a high electron mobility. However, if nanowhisker 1 was doped with the opposite conductivity type dopant (i.e., p-type dopant) from the n-type enclosure 6, as suggested in the Office Action, then this would introduce dopants into the high conductivity channel, causing impurity scattering and a reduction in mobility in the HEMT channel, thereby hampering or destroying the HEMT-type conduction mechanism. Thus, the proposed modification in the Office Action would disrupt the band structure shown in Figure 2 of Yazawa and may prevent or disrupt the one dimensional electron gas from forming in the nanowhisker. Without a high-mobility channel, the resultant device would not behave like a HEMT-type FET and would therefore change the principle of operation of Yazawa's FET or render it inoperative, since there would be no high-mobility path for carriers to travel from the source to the drain.

With regard to choice (b), when the nanowhisker 1 of Yazawa is doped n-type and the enclosure layer 6 is insulating, the enclosure 6 acts as an isolation layer to isolate adjacent nanowhiskers. In this case, the transistor operates similar to a conventional FET in which doped semiconductor channel is isolated from adjacent channels by an isolation region or layer (similar to a field oxide isolation in a bulk transistor). One of ordinary skill in the art would not substitute an insulating isolation region with a doped semiconductor region.

Thus, it would not have been obvious to one of ordinary skill in the art to modify Yazawa's FET in the way suggested in the Office Action. Therefore, Applicants respectfully request that this rejection be withdrawn.

IV. Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The

Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check or credit card payment form being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date 1/28/08

By _____

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